wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that a receiver processes said OFDM modulated signal by varying analog/digital transposition means and digital transposition means as a function of the extracted subband(s).

REMARKS

It is respectfully requested that the above amendments be made prior to calculating the filing fee. In this Preliminary Amendment, claims 1-13 are canceled, and new claims 14-45 are added to further clarify the invention. All of claims 14-45 are in condition for allowance. Examination and notice to that effect is respectfully requested. The Examiner is invited to contact the undersigned attorney at the number listed below if such a call would in any way facilitate examination of the application.

Respectfully submitted,

KINNEY & LANGE, P.A.

Date: July 31, 2001

By _____

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IN THE SPECIFICATION

At page 1, between lines 1 and 2, please insert the following paragraph (marked up version attached in Appendix):

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of Patent application Serial No., 08/765,162 filed on December 13, 1196 and completed on March 19, 1997, entitled OFDM SIGNAL ORGANIZED SO AS TO SIMPLIFY RECEPTION, which was a 371 National Phase application of PCT/FR95/00775 filed June 17, 1995

IN THE CLAIMS

Please cancel claims 1-13 without prejudice, and add new claims 14-45 as follows:

--14.(New) A method for transmitting and receiving at least two independent source signals, comprising the steps of:

obtaining said at least two independent source signals, in the form of independent series of coded bits;

assigning a determined frequency band to an OFDM signal to be transmitted, several approximately orthogonal carrier frequencies being defined in said frequency band;

breaking down said frequency band into at least two frequency subbands, each of said subbands comprising a set of said approximately orthogonal carrier frequencies;

assigning each of said frequency subbands to one of said independent source signals;

selectively modulating the carrier frequencies of each frequency subband with coded bits of the corresponding source signal;

grouping said modulated frequency subbands to form a modulated OFDM signal;

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tuning and transmitting the modulated OFDM signal as a whole;

receiving the modulated OFDM signal in a receiver;

extracting from the modulated OFDM signal at least one, but not all the frequency subbands, by filtering; and

performing demodulation processing solely on the frequency carriers contained in the extracted subbands of the modulated OFDM signal.

15. (New) Method according to claim 14, characterized in that said subbands are adjacent.

16.(New) Method according to claim 14, characterized in that said subband grouping step is preceded by an independent coding step and frequency and time interlacing of each of said source signals, so as to obtain a set of coded signals designed to modulate each of said carrier frequencies of the subband assigned to said source signal.

17.(New) Method according to claim 14, wherein the modulated OFDM signal is a single signal tuned as a whole by a sole modulator modulating simultaneously the substantially orthogonal frequency carriers, the orthogonal frequency carriers being orthogonal in each subband and from subband to subband.

18.(New) Method according to claim 14, characterized in that said subbands have identical bandwidths.

19.(New) Method according to claim 14, characterized in that said source signals are assigned to said subbands in a manner that varies with time, in order to maximize the frequency diversity.

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20.(New) Method according to claim 19, characterized in that said assignment is modified on each transmission of a frame of said signal.

21.(New) Method according to claim 14, characterized in that at least a first of said source signals corresponds to basic information for a program and at least a second of said source signals corresponds to information complementary to said basic information, in order to define at least two receiver quality levels:

- a first quality level applicable to receivers capable of processing only the subband corresponding to said first course signals; and
- a second quality level corresponding to receivers capable of processing subbands corresponding to the first and second source signals.

22. (New) Method according to claim 14, characterized in that performing demodulation processing further comprises:

selecting a given program corresponding to at least one of the frequency subbands using a selection means; and

acting on the carrier frequencies contained in the selected subband(s) using a mathematical transformation means.

23.(New) Method according to claim 22, characterized in that said selection means include analog transposition means including a first RF transposition oscillator and a second IF transposition oscillator, and means of controlling an oscillation frequency of said first RF transposition oscillator and/or said second IF transposition oscillator as a function of the selected subbands, so that the selected subbands are centered on a predetermined frequency.

24.(New) Method according to claim 22, characterized in that said selection means comprises:

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first analog transposition means and second digital transposition means that are variable as a function of the selected subband(s); and

subsampling means.

25.(New) Method according to claim 22, characterized in that said mathematical transformation means act on a number of carrier frequencies slightly exeeding the number of carrier frequencies contained in the extracted subband(s), so as to compensate for imperfection due to extraction filtering of said subbands.

26.(New) A method for transmitting and receiving an OFDM signal, the method comprising:

obtaining at least two independent source signals, each source signal being in the form of an independent series of coded bits;

assigning a determined frequency band on which the OFDM signal will be transmitted defining approximately orthogonal carrier frequencies in the determined frequency band;

breaking the determined frequency band down into at least two frequency subbands, each of said subbands comprising a set of said approximately orthogonal carrier frequencies;

assigning each independant source signal to one of said frequency subbands;

transmitting a modulated OFDM signal by selectively modulating the carrier frequencies of each frequency subband with the coded bits of the correspondingly assigned source signal and grouping said modulated OFDM signal being tuned and transmitted as a whole, so that said frequency carriers are orthogonal in each of said subbands and from subband to subband;

receiving the modulated OFDM signal;

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extracting at least one but less than all of the frequency subbands from the received OFDM signal by filtering; and

performing demodulation processing solely on the frequency carriers contained in the extracted subbands of the received modulated OFDM signal.

27.(New) A receiver of at least one independent source signal, said independent source signals being transmitted according to the steps of:

obtaining said at least two independent source signals, in the form of independent series of coded bits;

assigning a determined frequency band to an OFDM signal to be transmitted, several approximately orthogonal carrier frequencies being defined in said frequency band;

breaking down said frequency band into at least two frequency subbands, each of said subbands comprising a set of said approximately orthogonal carrier frequencies;

assigning each of said frequency subbands to one of said independent source signals;

selectively modulating the carrier frequencies of each frequency subband with the coded bits of the corresponding source signal;

grouping said modulated frequency subbands to form a modulated OFDM signal;

tuning and transmitting the modulated OFDM signal as a whole;

said receiver comprising:

- a signal receiver of the modulated OFDM signal;
- an extractor of at least one, but not all the frequency subbands, by filtering from the modulated OFDM signal;

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– and a demodulation processor acting solely on the frequency carriers contained in the extracted subbands of the modulated OFDM signal.

28.(New) Receiver according to claim 27, characterized in that said extractor includes a first RF transposition oscillator and a second IF transposition oscillator, and a controller of the oscillation frequency of said first and/or said second oscillator as a function of selected subbands, so that they are centered on a predetermined frequency.

29.(New) Receiver according to claim 27, characterized in that said extractor comprises a first analog transposer and a second digital transposer that are variable as a function of the selected subband(s), and a subsampler.

30.(New) Receiver according to claim 27, characterized in that said demodulation processor comprises a mathematical transformation acting on a number of carrier frequencies slightly exceeding the number of carrier frequencies contained in the extracted subband(s), so as to compensate for the imperfection due to extraction filtering of said subbands.

31.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single

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signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband, so that a receiver can receive the whole modulated OFDM signal and process one source signal, without processing the whole OFDM signal.

32.(New) Signal according to claim 31, characterized in that said subbands are adjacent.

33.(New) Signal according to claim 31, characterized in that said subbands have identical bandwidths.

34.(New) Signal according to claim 31, characterized in that said source signals are assigned to said subbands in a manner that varies with time, in order to maximize the frequency diversity.

35.(New) Signal according to claim 34, characterized in that said assignment is modified on each transmission of a frame of said signal.

36.(New) Signal according to claim 31, characterized in that at least a first of said source signals corresponds to basic information for a program and at least a second of said source signals corresponds to information complementary to said basic information, in order to define at least two receiver quality levels:

- a first quality level applicable to receivers capable of processing only the subband corresponding to said first source signals; and
- a second quality level corresponding to receivers capable of processing subbands corresponding to the first and second source signals.

37.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carries, said carriers being modulated by distinct

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data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that the processing to be done in a receiver of said modulated OFDM signal is reduced.

38.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said course signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that it is possible to transmit several source signals without it being necessary to widen a frequency band allocated to said modulated OFDM signal.

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39.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that said modulated OFDM signal can be received and processed by at least two types of receivers, corresponding to at least two reception qualities:

- a first type of receivers processing a first set of at least one subband;
- a second type of receivers processing said first set of at least one subband and at least one second set of at least one subband.

40.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said

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OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that each subband can be coded with a distinct coding.

41.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that each subband can be specifically interlaced in time and/or in frequency.

42.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out

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demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that a receiver can select a given program, among at least two programs carried by said OFDM modulated signal.

43.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that a receiver processes said OFDM modulated signal by applying a DFT only on said extracted subbands.

44.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

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wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that a receiver processes said OFDM modulated signal by controlling an RF transposition oscillator and/or an IF transposition oscillator as a function of the extracted subband(s), so that they will be centered at a predetermined frequency.

45.(New) An OFDM signal to be transmitted to several receivers, said signal being composed of a plurality of substantially orthogonal frequency carriers, said carriers being modulated by distinct data and simultaneously transmitted to form said modulated OFDM signal on a determined frequency band, said OFDM signal including at least two source signals,

wherein each of said source signals is assigned to a distinct one of at least two frequency subbands, each of said at least two frequency subbands comprising a set of said substantially orthogonal frequency carriers, so that a receiver can extract at least one of said subbands, but not all subbands from the transmitted OFDM signal by filtering, and can carry out demodulation processing solely on the frequency carriers contained in the extracted subbands, said OFDM signal being a single signal tuned as a whole by a sole modulator modulating simultaneously said plurality of substantially orthogonal frequency carriers, said plurality of orthogonal frequency carriers being orthogonal in each subband and from subband to subband,

so that a receiver processes said OFDM modulated signal by varying analog/digital transposition means and digital transposition means as a function of the extracted subband(s).--

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ABSTRACT

The invention relates to a signal intended to be transmitted towards a plurality of receivers, of the type comprising at least two source signals and consisting of a plurality of independently modulated substantially orthogonal carrier frequencies distributed over a predetermined frequency band. According to the invention, said frequency band [(12)] is divided into at least two frequency sub-bands [(13_1 - 13_4)] each comprising a set of said substantially orthogonal carrier frequencies [(11)], and to each of said sub-bands is allocated one of said source signals, so that a receiver may retrieve from the transmitted signal, by filtration, at least one of said sub-bands and perform demodulation processing only on the carrier frequencies contained in the retrieved sub-bands. The invention also relates to a transmission process as well as to a receiver of such signal.

OFDM SIGNAL ORGANIZED SO AS TO SIMPLIFY RECEPTION

The field of the invention is signal transmission using simultaneously several orthogonal (or quasi-orthogonal) carrier frequencies, each coded by distinct data elements.

These signals are generally called OFDM (Orthogonal Frequency Division Multiplex) signals. This type of OFDM signal is used for example in the digital broadcasting system described particularly in French patent FR-86 09622 filed on July 2 1986, FR-86 09/622 filed on July 2 1986 published as number FR.2601 210 and in document... and in the document entitled "Principes de modulation et de codage canal en radiodiffusion numérique vers les mobiles" (Principles of channel modulation and coding in digital radio broadcasting to mobiles) (by M. Alard and R. Lassalle; U.E.R. review No. 224, August 1987, pp. 168-190) and known under the name of the COFDM (Coded Orthogonal Frequency Division Multiplex) system.

This COFDM system was developed largely as part of the European DAB (Digital Audio Broadcasting) project. It is digital. More generally, it enables the transmission of any type of digital or analog signal (sampled but not necessarily quantified).

Special demodulators must be used to demodulate these digital signals with frequency multiplexing. For example, this type of demodulator is described in the above mentioned patent document FR-86 09622.

Another method of creating this type of signal is described in "Synthesis of Band-Limited Orthogonal Signals for Multichannel Data Transmission" (Robert W. Chang, Bell System Technical Journal, December 1966, Vol. 45, No.10, pp 1775-1796). This method is based on the use of special filters for each carrier, processed independently and carrying an independent signal. It also suggests a corresponding reception technique.

It is known that one essential element of a multicarrier signal receiver is the demodulation circuit which extracts raw information carried by each carrier taken separately, from the received signal (the multiplex of orthogonal carriers).

Conventionally, this circuit carries out mathematical transform the signal, and for example a Discrete Fourier Transform (DFT). Many other transforms may be used. However, this type of circuit will be referred to as a DFT circuit in the following, for non-restrictive simplification purposes.

The complexity of this type of circuit is proportional firstly to the number of frequencies transmitted simultaneously (frequency dimension), and secondly to the duration T_s of transmitted symbols (time dimension). This DFT circuit is a complex and therefore expensive element. Therefore, it is essential that this circuit should be simplified, particularly for low cost receivers.

CLAIMS

1. Signal to be transmitted to several receivers, of the type including at least two source signals and composed of several substantially orthogonal carrier signals modulated independently and distributed on a determined frequency band,

characterized in that said frequency band (12) is organized into at least two frequency subbands (13_1 to 13_4) each comprising a set of said substantially orthogonal carrier frequencies (11),

and characterized in that one of said source signals (S_i) is assigned to each of said subbands, so that a receiver can extract at least one of said subbands from the transmitted signal by filtering, and can carry out demodulation processing solely on the carrier frequencies contained in the extracted subbands.

2. Signal according to claim 1, characterized in that said subbands (13_1 to 13_4) are adjacent.

3. Signal according to any one of claims 1 and 2, characterized in that said subbands (13_1 to 13_4) have identical bandwidths.

4. Signal according to any one of claims 1 to 3, characterized in that said source signals (Si) are assigned to said subbands (13_1 to 13_4) in a manner that varies with time, in order to maximize the frequency diversity.

5. Signal according to claim 4, characterized in that said assignment is modified on each transmission of a frame of said signal.

6. Signal according to any one of claims 1 to 5, characterized in that at least a first of said source signals (S_i) corresponds to basic information for a program and at least a second of said source signals (S_i) corresponds to information complementary to said basic information, in order to define at least two receiver quality levels:

- a first quality level applicable to receivers capable of processing only the subband corresponding to said first source signal; and
- a second quality level corresponding to receivers capable of processing subbands corresponding to the first and second source signals.

7. Method for the transmission of a signal according to any one of claims 1 to 6, said signal being transmitted to several receivers, and being of the type containing at least two standalone source signals (S_i) and composed of several substantially orthogonal carrier frequencies (11) modulated independently and distributed on a determined frequency band (12), characterized in that it comprises the following steps:

- assignment of a determined frequency band (12) to said signal, in which several approximately orthogonal carrier frequencies (11) are defined;
- breakdown of said frequency band (12) into at least two frequency subbands (13_1 to 13_4), each comprising a set of said approximately orthogonal carrier frequencies;
- reception of at least two source signals (S_i) to be transmitted;
- assignment of one of said frequency subbands to each of said source signals;
- grouping of said subbands, so as to form said signal to be transmitted; and
- transmission of said signal to be transmitted.

8. Method according to claim 7, characterized in that said subbands (13_1 to 13_4) are adjacent.

9. Method according to any one of claims 7 and 8, characterized in that said subband grouping step is preceded by an independent coding step (22_i) and frequency and time interlacing (23_i) of each of said source signals, so as to obtain a set of coded signals designed to modulate each of said carrier frequencies of the subband assigned to said source signal.

10. Receiver of a signal ccording to any one of claims 1 to 9, characterized in that it comprises:

- means of selecting a given program, corresponding to at least one of said subbands (13_1 to 13_4); and
- mathematical transformation means (47; 58) acting on the carrier frequencies contained in the selected subband(s).

11. Receiver according to claim 10, characterized in that said selection means include analog transposition means including a first RF transposition oscillator (43) and a second IF transposition oscillator (44), and means of controlling the oscillation frequency of said first and/or said second oscillator as a function of the selected subbands, so that they are centered on a predetermined frequency.

12. Receiver according to claim 10, characterized in that said selection means comprise first analog transposition means (51, 52) and second digital transposition means (54) that are variable as a function of the selected subband(s), and subsampling means (56).

13. Receiver according to any one of claims 10 to 12, characterized in that said mathematical transformation means (47; 58) act on a number of carrier frequencies slightly exceeding the number of carrier frequencies contained in the extracted subband(s), so as to compensate for the imperfection due to extraction filtering of said subbands.